TITLE

LABEL SWITCHING ROUTER HAVING INTERNAL CHANNEL SHARE FUNCTION OVER ATM, AND METHOD FOR SHARING INTERNAL CHANNEL USING THE SAME

CLAIM OF PRIORITY

[0001] This application makes reference to, incorporates the same herein, and claims all benefits accruing under 35 U.S.C. §119 from an application entitled *"LABEL SWITCHING ROUTER HAVING INTERNAL CHANNEL SHARE FUNCTION OVER ATM, AND METHOD FOR SHARING INTERNAL CHANNEL USING THE SAME"* earlier filed in the Korean Intellectual Property Office on 15 February 2003 and there duly assigned Serial No. 2003-9644.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to a label switching router (LSR) having an internal channel share function over an ATM which sets up internal channels in advance and shares internal channels when an external channel needs to be set up, and a method for sharing an internal channel using the same.

2. Description of the Related Art

[0003] In general, an Multiprotocol Label Switching network (or MPLS network) improves transmission of layer 3 (L3) packet by an internet protocol (or IP) header used in an existing local area network/wide area network (LAN/WAN), and thus efficiently and rapidly transmits the L3 packets by using a new label stack having a short length, namely an MPLS header. The connection structure of the MPLS network includes an end system for performing a router function, and LSRs classified into label edge routers (LER) positioned on contact points to the existing network, and core LSRs positioned in the MPLS network according to their functions.

[0004] An MPLS control protocol stack for supporting MPLS functions includes a label distribution protocol (LDP) layer for transmitting/receiving label values between the LSRs. An MPLS, also called a label switch path or LSP, is set up to transmit the L3 packets by the corresponding LDP layer according to the MPLS. In the ATM MPLS network, when the L3 packet is transmitted from the existing network such as the LAN through ATM (or Asynchronous Transfer Mode) access such as an IP over ATM (or IPOA) of the end system, an MPLS layer of an ingress or incoming ATM-LER positioned on the boundary of the ATM MPLS network transforms the L3 packet into ATM cells, and transmits the ATM cells to a core ATM-LSR through an ATM LSP determined by an LDP layer. Identically to general ATM cell transmission, the core ATM-LSR transmits the ATM cells to an egress or exiting ATM-LER by VPI/VCI (or virtual path identifier/virtual channel identifier) switching of the ATM cells in an ATM layer. The egress ATM-LER assembles the ATM cells into L3 packet and transmits the ATM cells to the existing network through the end system.

1   [0005] In order to set up an external channel such as the LSP or IPOA PVC (or permanent virtual

2   circuit), the virtual path (or VP) tunnels are set up in the form of a VP full mesh in the ATM MPLS

3   network. That is, the ATM MPLS network sets up the VP tunnels by using the internal channel set

4   process due to the external channel. When one external channel LSP or IPOA is set up, the internal

5   channels must then be connected as many as the value obtained by subtracting the set Forwarding

6   Engines (or FEs) 200 from the whole FEs 200. Accordingly, when N LSPs are set up, a number of

7   channels required in the ATM MPLS network is represented by following formula 1:

8   <Formula 1>

9   Network channel number = external channel number (N) + N * (FE number – 1)

10   [0006] Considering the mapping relations between the internal and external channels, the general

11   internal channel allocation restricts capacity of the ATM MPLS network. For example, when 16K

12   of LSP and 16K of IPOA PVC are needed per 622Mbps of FE in 10G of MPLS network, 512K of

13   channel capacity is required to set up channels. However, channel capacity per 622Mbps is restricted

14   to 64K, which influences the ATM MPLS network.

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16   **SUMMARY OF THE INVENTION**

17   [0007] It is therefore an object of the present invention to provide an improved LSR.

18   [0008] It is also an object of the present invention to provide an improved method for switching

19   ATM data through a network having LSR's.

[0009] It is also an object of the present invention to eliminate the consumption of unnecessary resources in a switch when possible.

[0010] It is further an object to provide a network and an method for switching data through the network that is faster, more efficient and has a broader bandwidth.

[0011] It is also an object of the present invention to share an internal channel to transfer data between an internal switch and a destination when the data originates in more than one source.

[0012] These and other objects may be achieved by having the internal channels in an MPLS network already set up before any data needs to be transferred and before an external channel arrives at the network. In addition, this invention allows for the sharing of the internal channels of the network thereby enhancing speed. By sharing channels instead of using many channels, resources are conserved in that unnecessary channels do not have to be set up.

[0013] Provided is a label switching router having an internal channel share function over an ATM which sets up an internal channel in advance in an ATM MPLS network and shares the internal channel when an external channel needs to be set up. Provided also is a method for sharing an internal channel using the same.

[0014] There is provided a label switching router having an internal channel share function over an ATM, the label switching router having a forwarding engine for setting up a label switched path by using a signaling protocol, extracting an egress forwarding engine number and a channel ID, allocating an extension tag, searching a previously-set internal channel, forming a forwarding information base/label information base(FIB/LIB) including the previously-set internal channel ID and the extension tag, adding a header having the internal channel ID and extension tag to a received

1 IP packet by referring to the forwarding information base/label information base, and forwarding the

2 IP packet. The label switching router further having a merging unit for receiving label switched path

3 set information from a peer forwarding engine, forming an extension information base/merging

4 table(EIB/MT) where an internal channel ID is mapped to an extension tag, performing merging

5 when receiving an IP packet having the extension tag, extracting the extension tag, mapping the

6 extension tag to the internal channel ID, and forwarding the IP packet to an internal channel having

7 the mapped internal channel ID. A single channel is shared and used to transmit data originating

8 from more than one source and going to a single destination instead of having a separate channel for

9 each originating source.

10 [0015] There is also provided a method for sharing an internal channel by using a label switching

11 router over an ATM, the method starting out with a first step where a forwarding engine sets up a

12 label switched path by using a signaling protocol, extracts an egress forwarding engine number and

13 a channel ID, allocates an extension tag, and forms a forwarding information base/label information

14 base table by using a previously-set internal channel. The second step being where the forwarding

15 engine adds a header having the internal channel ID and extension tag to a received IP packet by

16 referring to the forwarding information base/label information base, and forwards the IP packet. The

17 third step being where a merging unit receives label switched path set information from a peer (or

18 ingress) forwarding engine, forms an extension information base/merging table where an internal

19 channel ID is mapped in an extension tag. The method concludes with a fourth step where the

20 merging unit forwards a received IP packet having the extension tag to an internal channel having

21 the internal channel ID mapped to the extension tag by referring to the extension information

1 base/merging table.

BRIEF DESCRIPTION OF THE DRAWINGS

3 **[0016]** A more complete appreciation of the invention, and many of the attendant advantages thereof,

4 will be readily apparent as the same becomes better understood by reference to the following detailed

5 description when considered in conjunction with the accompanying drawings in which like reference

6 symbols indicate the same or similar components, wherein:

7 **[0017]** FIG. 1 is a structure diagram illustrating an ATM MPLS network;

8 **[0018]** FIG. 2 is a concept diagram illustrating a general process for setting up an LSP;

9 **[0019]** FIG. 3 is a structure diagram illustrating an ATM MPLS system having an internal channel

10 share function according to the principles of the present invention;

11 **[0020]** FIG. 4 is a block diagram illustrating an internal structure of a line interface card of FIG. 3;

12 **[0021]** FIG. 5 is a block diagram illustrating an internal structure of an ICB interface of FIG. 4;

13 **[0022]** FIG. 6 is a block diagram illustrating an internal structure of a forwarding engine of FIG. 3;

14 **[0023]** FIG. 7 is a block diagram illustrating an internal structure of a merging unit of FIG. 3;

15 **[0024]** FIG. 8 is a concept diagram illustrating a process for setting up an LSP according to the

16 principles of the present invention;

17 **[0025]** FIG. 9 is a flowchart illustrating the process for setting up the LSP in according to the

18 principles of the present invention; and

19 **[0026]** FIG. 10 is a flowchart illustrating a process for sharing an internal channel in according to

20 the principles of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0027] Turning now to the figures, FIG. 1 is a structure diagram illustrating an ATM MPLS network 10. Referring to FIG. 1, an IP packet 20 entering the MPLS network 10 is transformed into ATM cells 21 in a first LER 11 which is an ingress LER. The transformed ATM cells 21 are then switched by ATM switches along an LSP path. The IP packet 20 is reassembled from the ATM cells 21 in a third LER 13 which is an egress LER, and the IP packet is outputted from the MPLS network 10.

[0028] In FIG. 1, IP routing functions of a router such as IP packet assembling/segmentation, IP header analysis and processing, and routing table lookup are performed once in each LER 11 and 13, and the ATM cells 21 are rapidly ATM switched in the MPLS network 10. In addition, a data transmission path is identical to a connectionless IP network path. A transmission side of two adjacent routers on one path is upstream Ru and a reception side is a downstream Rd. A path calculated by a routing protocol operated in each network element is an LSP path. Here, a protocol used between the network elements is an LDP. That is, when the LSP is set up by the LDP, the first LER 11, which is an ingress LER, analyzes a header of the IP packet 20, and determines an LSP according to the destination IP address. Thereafter, the first LER 11 segments the IP packet 20 into the ATM cells 21, and transmits the ATM cells 21 to a first LSR 110 which is a peer LSR by using a selected label as a VPI/VCI value. The first through fourth LSRs 110 through 140 transmit the IP packet to the third LER 13, which is an egress LER, by cell switching without assembling/segmenting the IP packet. The third LER 13 reassembles the input cells, analyzes an IP header, and performs L3 forwarding.

[0029] The LER's includes a plurality of line interface cards (LIC) for connecting the LER to an

1   external environment (such as terminals or other systems). The LER's also include a plurality of

2   forwarding engines (FE) for forwarding packets. Each of the LICs may include a variety of

3   interfaces such as an ATM interface, Ethernet and frame relay. The external terminals or other

4   systems can be connected to the LERs through the plurality of LICs in the form of various services.

5   Such connections are connected to the FEs so that they can process the input packets and transmit

6   them to destinations.

7   [0030] On the other hand, when the MPLS LER/LSR over the ATM sets up the LSP through the

8   MPLS network, a VP full mesh type internal channel must be determined between the FEs. Each

9   FE must set up VPI channels of the whole FEs composing the ATM MPLS network. For example,

10   as illustrated in FIG. 2, FE-1 200b must set up three LSPs (34, 35 and 36) for one channel (CH), the

11   three paths being FE-0→FE-1, FE-2→FE-1 and FE-3→FE-1. In addition, four open channels 1, 2

12   3 and CH are opened in consideration of one IPOA PVC. As will be discussed later, this is

13   unnecessary.

14   [0031] The process for setting up channels will now be explained. In initialization of the ATM

15   MPLS network, virtual path (VP) tunnels are set up between the whole FEs in the ATM MPLS

16   network by a general switch management protocol (GSMP). The VP tunnel information is registered

17   in a VP mapping table of the MPLS LER. For example, as illustrated in FIG. 2, entry information

18   such as FE-0, FE-1, VPI(1), FE-2, FE-1, VIP(2), FE-3, FE-1 and VPI(3) is registered in the VP

19   mapping table of the FE-1 200b. After this registration, when receiving an LSP or IPOA PVC

20   connection request, the MPLS LER then allocates channels, and searches VPI information connected

21   to the FE-1 200b in the VP mapping table. The MPLS LER searches VPI values of FE-1, FE-0,

1   VPI(1), VCI(4), FE-1, FE-2, VPI(2), VCI(5), FE-1, FE-3, VPI(3) and VCI(6), and receives VCI

2   values thereof from a VCI pool.

3   **[0032]** Turning to FIG. 3, FIG. 3 is a structure diagram illustrating an ATM MPLS system 300

4   having an internal channel share function in according to the principles of the present invention. As

5   illustrated in FIG. 3, the ATM MPLS system 300 having the internal channel share function includes

6   a switch 301, a main control unit 302, an IP/MPLS control unit 303, LICs 304, MUX/DMUXes 305,

7   FEs 306, and VC or virtual channel merging units (VM) 340.

8   **[0033]** The switch 301 switches ATM cells. The main control unit 302 controls software parts,

9   namely call processing, maintenance/repair, charging and statistics. The LICs 304 match with

10   external links, distinguish ATM data flows through a VPI/VCI, control traffic types and properties

11   by ATM data flows, and transmit the ATM data flows to the switch 301.

12   **[0034]** Turning now to FIG. 4, FIG. 4 illustrates, in detail, an LIC 304 of FIG. 3. LIC 304 is made

13   up of a line physical interface 308, a port control unit 310 and an Interface Control Block or ICB

14   interface 311. Each of these devices are controlled by a main control unit 302. LIC 304 is further

15   made up of LINE MUX/DMUX 309.

16   **[0035]** Turning now to FIG. 5, FIG. 5 illustrates, in detail, internal control block or ICB interface

17   311 of FIG. 4. As depicted in FIG. 5, the ICB interface 311 of the LIC 304 includes a cell

18   transmitting/receiving unit 312, a cell format transforming unit 313 and an internal cell

19   transmitting/receiving unit 314. Each device 312, 313 and 314 is controlled by the main control unit

20   302.

21   **[0036]** The cell transmitting/receiving unit 312 transmits/receives cells to/from the port control unit

310. When the port control unit 310 and the ICB interface 311 have different cell formats, the cell

format transforming unit 313 equalizes the cell formats. The internal cell transmitting/receiving unit

314 transmits/receives cells format-transformed into internal cells. The cell format transforming unit

313 is required because most of the ATM exchanges transform standard ATM cells into internal cells

and switch them. In addition to the fields of the standard ATM cell, the internal cell further includes

a field for storing extra information such as an internal channel ID for switching in the exchange.

[0037] The line physical interface 308 of the LIC 304 of an ingress LER extracts the standard ATM

cells from a transmission frame, and a line physical interface of an egress LER adds the standard

ATM cells to the transmission frame, and transmits it. The cell format transforming unit 313 of the

ICB interface 311 of the LIC 304 of the ingress LER processes the standard ATM cells according

to a corresponding protocol, and transforms the ATM cells into internal cells. The cell format

transforming unit 313 stores the internal channel ID mapped to the VPI/VCI value in the field of the

ATM standard cell by referring to an input end table mapping the VPI/VCI value to the internal

channel ID.

[0038] When the internal channel ID mapped to the VPI/VCI value of the standard ATM cells is

stored in the fields of the internal cells, a cell format transforming unit of the egress LER processes

the internal cells according to a corresponding protocol, and transforms them into the standard ATM

cells. Here, the cell format transforming unit stores the VPI/VCI value mapped to the internal

channel ID in the fields of the standard ATM cells by referring to an output end table mapping the

internal channel ID to the VPI/VCI value. On the other hand, the IP/MPLS control unit 303

performs software functions such as an IP, routing protocol or RP, GSMP and LDP.

[0039] The FEs 306 assemble the IP packets and analyze the IP header of the IP packets. In addition, the FEs 306 generate labels according to the analyzed IP headers, add the labels to the IP packets, segment the IP packets into the ATM cells, and transmit the ATM cells to a succeeding node (for example, exchange or router). The FEs 306 are hardware boards for rapidly processing various traffic such as IP packets, point-to-point protocol or PPP packets and MPLS packets inputted to the ATM MPLS exchange, and transmitting them to corresponding output interfaces.

[0040] Turning now to FIG. 6, FIG. 6 illustrates in detail forwarding engine (FE) 306 of FIG. 3. As illustrated in FIG. 6, the FE 306 includes an input end ICB interface 315, an SAR (or segmentation and reassembly or just segmentation) receiving unit 316, a lookup control unit 317, an FIB/LIB 323, an SAR transmitting unit 318, a control memory 320, a packet memory 321 of the SAR receiving unit 316, a control memory 324, a packet memory 325 of the SAR transmitting unit 318, and an output end ICB interface 319. The control memories 320 and 324 store SAR control information, and the packet memories 321 and 325 store received packets. The input end ICB interface 315 transforms the internal cell into the standard ATM cells to perform SAR, and copies and stores an internal channel access ID stored in the fields of the internal cells in specific fields of the standard ATM cells. The SAR receiving unit 316 reassembles the standard ATM cells having the same internal access ID to generate the IP packet, and transmits the IP packet to the lookup control unit 317.

[0041] In addition to the internal channel ID information for routing between the FEs 306, an extension tag must be set up in the FIB/LIB 323 of the FE 306 of the ingress LER to share the internal channel. The internal channel ID serves to distinguish internal channels set up between the

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1 FE 306 of the ingress LER and the FEs of the egress LER. In the related art, different internal

2 channel IDs are allocated according to an external VPI/VCI, and thus a plurality of internal channel

3 IDs are set up between the FEs of the ingress LER and the FEs of the egress LER. However,

4 according to the principles of the present invention, the internal channel ID is not newly set up when

5 the external VPI/VCI is set up. Instead, in the present invention, a previously established internal

6 channel ID is used, and the external VPI/VCI is distinguished by using the extension tag (which will

7 later be explained with reference to FIG. 8). Accordingly, when the external VPI/VCI is set up, the

8 internal channel is not newly set up but routed to the same path by using the previously-set internal

9 channel ID, which extends an available bandwidth. The extension tag is mapped to the newly-set

10 external VPI/VCI, and the VPI/VCI mapped to the extension tag is designated in an extension

11 information base/merging table (EIB/MT) 335 of the VC merging unit or VM 340 of the egress LER.

12 [0042] The lookup control unit 317 reads the IP address, the mapped internal channel ID and

13 extension tag, and the label from the FIB/LIB 323, performs IP lookup for L3 switching for adding

14 them to the header of the IP packet, and transmits the IP packet to the SAR transmitting unit 318.

15 The SAR transmitting unit 318 segments the IP packet to reproduce the standard ATM cells storing

16 the internal channel ID in their specific fields. The output end ICB interface 319 transforms the

17 standard ATM cells into the internal cells, and copies the internal access ID stored in the fields of

18 the standard ATM cells to the fields of the internal cells. In the MPLS system using the ATM

19 exchange, when a data rate of one port which is a basic unit of the switch 301 is greater than a data

20 rate of one LIC, the MUX 305 combines a plurality of LIC data streams to form one switch

21 port-sized data stream. The VMs 340 receive the IP packet having the capsulated extension tag from

1   the FEs 306, extract the extension tag, confirm the internal channel according to the extension tag,

2   and transmit the IP packet to the internal channel. The external channel information corresponding

3   to the extension tag must be managed in a connection extension information base/merging

4   table(EIB/MT) 335 of the VM 340.

5   [0043] Turning now to FIG. 7, FIG. 7 illustrates in detail VM 340 of FIG. 3. The VM 340 includes

6   an input end ICB interface 326, an SAR receiving unit 327, a lookup control unit 328, an EIB/MT

7   335, an SAR transmitting unit 329, a control memory 331 and a packet memory 332 of the SAR

8   receiving unit 327, a control memory 333 and a packet memory 334 of the SAR transmitting unit

9   329, and an output end ICB interface 330. The control memories 331 and 333 store SAR control

10   information, and the packet memories 332 and 334 store received packets. The input end ICB

11   interface 326 transforms the internal cells into the standard ATM cells to perform SAR, and copies

12   and stores the internal channel access ID stored in the fields of the internal cells in specific fields of

13   the standard ATM cells. The SAR receiving unit 327 reassembles the standard ATM cells having

14   the same internal access ID to generate the IP packet, and transmits the IP packet to the lookup

15   control unit 328. The lookup control unit 328 confirms the extension tag of the IP packet, reads the

16   mapped internal channel ID, stores it in a corresponding field of the IP packet, and transmits the IP

17   packet to the SAR transmitting unit 329. The SAR transmitting unit 329 segments the IP packet to

18   reproduce the standard ATM cells storing the internal channel ID in their specific fields. The output

19   ICB interface 330 transforms the standard ATM cells into the internal cells, and copies the internal

20   access ID stored in the fields of the standard ATM cells to the fields of the internal cells.

21   [0044] A cell format transforming unit (not illustrated) which is a succeeding unit of the VM 340

1 of the egress LER processes the internal cells according to a corresponding protocol, and transforms

2 the internal cells into the standard ATM cells. Here, the cell format transforming unit stores the

3 VPI/VCI value mapped to the internal channel ID in the fields of the ATM standard cells by referring

4 to an output end table mapping the internal channel ID to the VPI/VCI value. Thereafter, a line

5 physical interface (not illustrated) of the egress LER adds the standard ATM cells to a transmission

6 frame, and transmits it.

7 [0045] FIG. 8 is a concept diagram illustrating the method for sharing the internal channel in the

8 ATM MPLS network according to the principles of the present invention. The main control unit 302

9 registers the LSP having a destination address (for example, IP-A, IP-B) by the GSMP. The main

10 control unit 302 searches the FE number of the egress LER from the registered LSP information, and

11 also searches the internal channel ID (used by the FE of egress LER to externally transmit the ATM

12 cells) corresponding to the destination IP address to which the FE of the egress LER intends to

13 transmit cells. In addition to the FE number of the egress LER and the internal channel ID, the main

14 control unit 302 extracts and manages the VPI/VCI.

15 [0046] Thereafter, the main control unit 302 receives the extension tag for the internal channel ID

16 used by the egress FE to transmit the ATM cells. Here, the main control unit 302 receives an

17 extension tag that has not been allocated to the other channel IDs. For example, in the case of the

18 IP packet having the destination IP address of IP-A, when the FE number of the output channel is

19 '1' and the channel ID is '1' in the LSP information, if 'e' has not been allocated to the other channel

20 IDs having the FE number of '1', the main control unit 302 of the ingress LER receives 'e' for the

21 extension tag indicating the destination IP-A. Similarly, in the case of the IP packet having the

1   destination IP address of IP-B, when the FE number is '1' and the channel ID is 'a', if 'f' has not

2   been allocated to the other channel IDs having the FE number of '1', the main control unit 302

3   receives 'f' for an extension tag indicating the destination IP-B.

4   [0047] Here, the FEs of the ingress LER have the same egress FE, and use the same extension tag

5   for the destination IP address from the egress FE to the same internal channel. Therefore, when the

6   egress FE is '1' and the channel ID is '1', the FE-2 control unit receives the same extension tag 'e'.

7   Also, when the egress FE is '1' and the channel ID is 'a', the FE-2 control unit receives the same

8   extension tag 'f'.

9   [0048] The main control unit 302 of the router searches the previously-set internal channel to the

10   corresponding egress FE in the VP mapping table. For example, when the channel ID of the

11   previously-set internal channel from FE-0 to FE-1 is '2', the main control unit 302 sets up the

12   channel ID to be '2', designates the allocated extension tag, and generates a forwarding information

13   base/label information base (FIB/LIB) 323 for a newly-set LSP path.

14   [0049] In addition, when the channel ID of the previously-set internal channel from FE-2 to FE-1

15   is '3', the main control unit 302 sets up the channel ID to be '3', designates the extension tag, and

16   generates a forwarding information base/label information base FIB/LIB 323 for a newly-set LSP

17   path.

18   [0050] Thereafter, the egress main control unit 302 receives the LSP set information from the main

19   control unit 302, and generates and stores an extension information base/merging table EIT/MT 335.

20   In the extension information base/merging table EIT/MT 335, the internal channel ID is mapped to

21   the extension tag. For example, when the extension tag is 'e', the channel ID is mapped to '1', and

1   when the extension tag is 'f', the channel ID is mapped to 'a'.

2   **[0051]** The main control unit 302 generates a merging table for the internal channel ID, and stores

3   it in the mapping table. For example, the internal channel having the internal channel ID of '2' is

4   mapped to the internal channel having the internal channel ID of '1', and the internal channel having

5   the internal channel ID of '3' is mapped to the internal channel having the internal channel ID of 'a'.

6   **[0052]** On the other hand, when the procedure of setting up the LSP is finished, the FE of the ingress

7   LER receiving the IP packet looks up the forwarding information base/label information base

8   FIB/LIB 323, adds the allocated internal channel ID, the extension tag and the label to the IP packet,

9   and transmits it to the channel having the internal channel ID. The IP packet is segmented to ATM

10   cells, and transmitted to the internal channel. The switch performs switching according to the

11   internal channel ID. For example, when FE-0 receives the IP packet having the destination IP

12   address of IP-A, it looks up the forwarding information base/label information base FIB/LIB 323,

13   adds the internal channel ID of '2', the extension tag of 'e' and the label to the IP packet, segments

14   the IP packet to generate a plurality of ATM cells having the internal channel ID of '2' and the

15   extension tag of 'e', and transmits them to the internal channel having the internal channel ID of '2'.

16   Likewise, when FE-2 receives the IP packet having the destination IP address of IP-B, it looks up

17   the forwarding information base/label information base FIB/LIB 323, adds the internal channel ID

18   of '3', the extension tag of 'f' and the label to the IP packet, segments the IP packet to generate a

19   plurality of ATM cells having the internal channel ID of '3' and the extension tag of 'f', and

20   transmits them to the internal channel having the internal channel ID of '3'.

21   **[0053]** The FE of the egress LER merges the ATM cells from the same internal channel ID, and

1 searches the internal channel ID to which the ATM cells mapped to the extension tag will be

2 transmitted by referring to the extension information base/merging table EIB/MT 335. Thereafter,

3 the FE of the egress LER transmits the ATM cells having the same extension tag to the internal

4 channel having the internal channel ID. For example, when FE-1 receives the ATM cells having the

5 internal channel ID of '2', the extension tag of 'e' and the destination IP address of 'IP-A' from

6 FE-0, it confirms that the internal channel ID is '1' through the extension information base/merging

7 table EIB/MT 335 by referring to the extension tag of 'e', and transmits the ATM cells to the channel

8 having the internal channel ID of '1'. In the case that FE-1 receives the ATM cells having the

9 internal channel ID of '3', the extension tag of 'f' and the destination IP address of 'IP-B' from FE-2,

10 it confirms that the internal channel ID is 'a' through the extension information base/merging table

11 EIB/MT 335 by referring to the extension tag of 'f', and transmits the ATM cells to the channel

12 having the internal channel ID of 'a'.

13 [0054] Each FE forwards data to be transferred to a corresponding switch, and switch block 301

14 transfers received packets to a VM of a corresponding block. The receiving VM reallocates received

15 data to corresponding CHIDs.

16 [0055] Referring to FIG. 8, the packet forwarded to the switch in FE-0 and FE-2 is transferred via

17 an internal channel to VM-1. VM-1 then allocates the packet to the CHIDs.

18 [0056] The novel channel sharing will now be described in conjunction with FIG. 8. In FIG. 8,

19 FIB/LIBs connected to the (FE-0, VM-0) and (FE-2, VM-2) is allocated with different internal

20 channel IDs mapped with IP addresses. So, when packets of equal VPI and VCI and different CHIDs

21 are introduced into switch 301 as illustrated in FIG. 8, the packets are transferred to VM-1 via a

1 single channel 400 instead of using multiple channels, one for each source. This is different from

2 the scenario of FIG. 2 where when each of (FE-0, VM-0), (FE-2, VM-2) and (FE-3, VM-3) forwards

3 packets to (FE-1, VM-1), different channels (1, 2, 3) are used to deliver the packets from switch 210

4 to (FE-1, VM-1). By using different channels 1, 2, 3 in FIG. 2, the number of channels is

5 disadvantageously large. Also, unnecessary resources are consumed to set up each of these channels

6 between switch 210 and (FE-1, VM-1).

7 [0057] The present invention solves the problem of FIG. 2 by transferring the packets of equal VPI

8 and VCI having different CHIDs using only a single channel 400. Therefore, the packets the packets

9 from (FE-0, VM-0) and (FE-2, VM-2) are transferred in a package by sharing internal channel 400

10 from switch 301 to VM-1, the destination of transmission. By using a single channel 400 in FIG.

11 8 instead of many channels in FIG. 2, unnecessary channel setting is eliminated.

12 [0058] Turning to FIG. 9, FIG. 9 is a flowchart illustrating the process for setting up the LSP in

13 accordance with the preferred embodiment of the present invention. As illustrated in FIG. 9, the

14 main control unit 302 of the ingress LER registers the LSP having the destination address by the

15 GSMP (S110). The main control unit 302 of the ingress LER searches the FE number of the egress

16 LER from the registered LSP information, and also searches the internal channel ID corresponding

17 to the destination IP address to which the FE of the egress LER transmits cells (S112). In addition

18 to the FE number and the internal channel ID, the FE of the egress LER extracts and manages the

19 VPI/VCI. Thereafter, the main control unit 302 of the ingress LER receives the extension tag for the

20 internal channel ID used by the egress FE to transmit the ATM cells. Here, the main control unit 302

21 of the ingress LER receives the extension tag which has not been allocated to the other channel IDs

1   (S114). The main control unit 302 of the ingress LER searches the previously-set internal channel

2   to the corresponding egress FE in the VP mapping table (S116). Then, the main control unit 302 of

3   the ingress LER generates the forwarding information base/label information base FIB/LIB table 323

4   having the searched internal channel ID and extension tag (S118). The main control unit 302 of the

5   egress LER receives the LSP set information from the ingress main control unit 302, and generates

6   and stores this information in an extension information base/merging table EIB/MT 335. Here, the

7   internal channel ID is mapped to the extension tag in the extension information base/merging table

8   EIB/MT 335 (S122).

9   [0059] Turning now to FIG. 10, FIG. 10 is a flowchart illustrating a process for sharing the internal

10 channel in accordance with the preferred embodiment of the present invention. Referring to FIG.

11 10, when the procedure of setting up the LSP is finished, the FE of the ingress LER receiving the IP

12 packet (S210) looks up the forwarding information base/label information base FIB/LIB 323, adds

13 the allocated internal channel ID, the extension tag and the label to the IP packet (S212), and

14 transmits it to the channel having the internal channel ID (S214). Here, the IP packet is segmented

15 to ATM cells, and transmitted to the internal channel, and the switch performs switching according

16 to the internal channel ID.

17 [0060] The FE of the egress LER merges the ATM cells from the same internal channel ID (S216),

18 and searches the internal channel ID to which the ATM cells mapped to the extension tag will be

19 transmitted by referring to the extension information base/merging table EIB/MT 335 (S218).

20 Thereafter, the FE of the egress LER transmits the ATM cells having the same extension tag to the

21 internal channel having the internal channel ID (S220).

[0061] On the other hand, the procedure of setting up the LSP has been described in this embodiment, but the procedure of setting up the IPOA PVC is performed in the same manner.

[0062] As discussed earlier, in the related art, when the external channel such as the LSP and the IPOA PVC is set up, resources of the MPLS network are consumed to set up the internal channel, thereby reducing the whole capacity of the MPLS network. In accordance with the present invention, the resources of the MPLS network can be efficiently used by sharing the internal channel.

[0063] While the invention has been illustrated and described with reference to a certain preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.